MAGNETORESISTIVE SENSOR HAVING A SELF ALIGNED LEAD OVERLAY STRUCTURE AND METHOD OF FABRICATION THEREOF

[0001] The present invention is related to commonly assigned application Ser. No. 10/243,271 entitled THIN FILM HEAD READER WITH LEAD OVERLAY AND METHOD OF FABRICATION THEREOF, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to magnetoresistive sensors and more particularly to a lead overlay sensor design that provides for reduced trackwidth size and improved trackwidth control.

[0004] 2. Description of the Related Art

[0005] Digital memory lies at the heart of all computer systems. Magnetic Disk Drives provide this memory function in most modern computer systems, due to their ability to inexpensively store large amounts of data in such a manner that the data can be immediately, randomly retrieved. A magnetic disk drive includes one or more rotating magnetic disks, magnetic write and read heads that are suspended by a suspension arm above the rotating disk and an actuator that swings the suspension arm to place the read and write heads over selected circular tracks on the rotating disk. The read and write heads are directly mounted on a slider that has an air bearing surface (ABS). When the disk rotates, viscous forces in the air cause the air immediately adjacent to the disk to move with the disk. The ABS is aerodynamically configured to allow the slider to fly upon this moving air immediately adjacent to the disk surface.

[0006] As the disk moves past the slider, the write head emits magnetic flux pulses in order to imprint a magnetic signal onto the disk. These magnetic signals can then be read by the read head by moving the slider over a desired track and read the magnetic signal as it moves past the read head.

[0007] Various magnetic sensors have been used to read data from a magnetic medium. Some prior art disk drives have used anisotropic magnetoresistive (AMR) sensors, while more recently disk drive devices have employed giant magnetoresistive sensors (GMR) also known as spin valves. various other sensors have been proposed as well, such as tunneling magnetoresistive sensors (TMR). At present, GMR sensors are by far the most widely used and as such will be described in more detail herein. A GMR sensor operates on what has been called the "spin valve effect", and includes a non-magnetic conductive spacer material sandwiched between layers of magnetic material. The layer at one side of the spacer material has a magnetic moment that is pinned in a given direction, this layer is generally referred to as the pinned layer. The magnetic material at the other side of the spacer layer has a magnetization that is biased perpendicular to that of the pinned layer, but is free to rotate in the presence of a magnetic field. This layer is generally referred to as the free layer. The selective spin scattering of electrons passing through the sensor causes the electrical resistance of the sensor to change as the angle of the magnetization of the free layer relative to that of the pinned layer changes. In this way, as the sensor moves passed a magnetic field produced by the passing magnetic disk, the angle of the free layer magnetization changes, thereby changing the resistance of the sensor. This change in resistance is detected by passing a sense current through the sensor and detecting the voltage change across the sensor.

[0008] The computer industry constantly requires larger memory storage capacity in ever smaller devices. One way to increase data storage efficiency is to reduce the width of a track of data. The reduction of track width allows more tracks of data to be stored on a single disk. One attempt to minimize track width can be more readily understood with reference to **FIG. 1** which describes a read sensor **10** having a lead overlay design. The sensor **10** is built upon a gap layer **12**, which is an electrically insulating, non-magnetic material. An antiferromagnetic material **14** is formed over the gap layer and is used to fix the magnetization of a magnetically pinned layer **16**, in a manner which will be familiar to those skilled in the art. An electrically conductive, non-magnetic spacer layer **18** is formed over the pinned layer, and a magnetically free layer **20** is formed over the spacer layer **18** at the side opposite the pinned layer. Hard bias layers **24** are formed at either side of the sensor **10**. The hard bias layers are constructed of a material having a high magnetic moment, which when magnetized acts to bias the magnetization of the free layer in a desired direction due to magnetostatic forces between the hard bias material **24** and the free layer **20**. In the lead overlay design described herein, electrical leads **26** are formed over the top of the sensor **10** at portions of the sensor. The leads **26** provide the sense current to the sensor, and as will be appreciate by those skilled in the art, the track width TW of such a design is defined as the distance between the leads. Prior art lead overlay designs and methods of manufacture make accurate track width definitions somewhat difficult as will be described in greater detail below in a discussion of the prior art methods of making such lead overlay sensor.

[0009] With continued reference to **FIG. 1**, the hard bias material **22** tends to slightly overlap the free layer **20**, resulting in what has been called a "birds beak"**26**. Such a birds beak **26** is undesirable because it tends to pin the overlapped portion of the free layer and makes accurate biasing and track width definition difficult.

[0010] With reference to **FIGS. 2 through 4** an exemplary method of manufacturing such a lead overlay sensor **10** will be described. With reference to **FIG. 2, a** layer of sensor materials **28** is formed over the gap material **12**. The layer of sensor material could include the various layers making up the sensor **10** as described with reference to **FIG. 1** or could be layers making up some other type of sensor such as AMR, TMR etc. A first mask **30**, which could be a bi-layer photoresist mask is formed over the sensor layer **28** and is formed of such a width as to define the edges of the sensor. An ion milling process indicated by arrows **32** is used to remove sensor material not protected by the mask **30**. This process is generally referred to in the industry as the K2 milling process, or just K2. After the ion milling process **32** has been completed, the hard bias layers **22** are deposited, using the same mask **30** that was used to define the edges of the sensor **10**. As can be seen with reference to **FIG. 3**, this method of construction allows the hard bias layers **22** to slightly overlap the sensor **10**. After the hard bias **22** has been deposited, the first mask **30** is removed. The first mask **30** is replaced with a second mask **34**, which is narrower than the first mask, and can also be constructed as a bi-layer